Signature-based Searches for New Physics in Diphoton Events; ....[γγ+X]....

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Outline

- Motivation

- Search Strategy

- First look in ~400 pb-1 diphoton data
  Diphoton Event Selection and Photon ID

- Searches for Anomalous Events and Results
  In this talk, I will focus on diphoton+X production,
  where X is MET, Jets
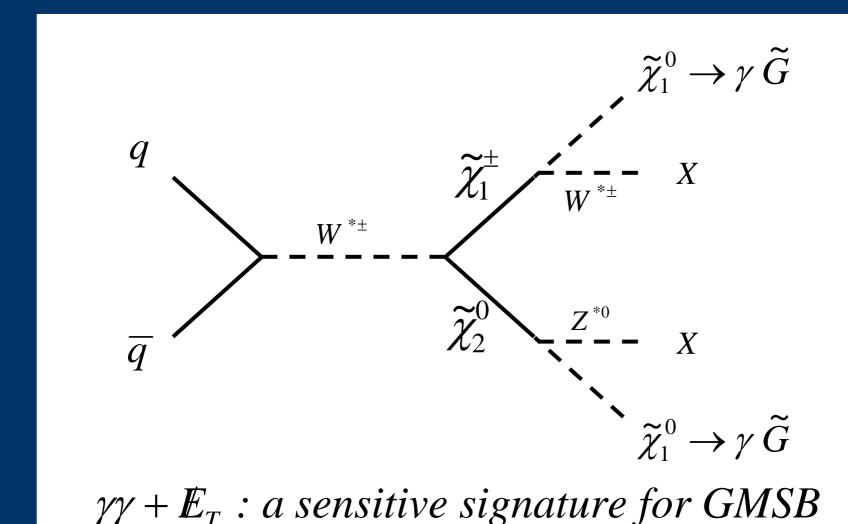
- Next to do…

Motivation [I]

- The Standard Model has been enormously successful, but it is incomplete.

- Many theories/models attempt to address these issues, but none have been experimentally verified yet…

- Many reasons to believe there are new fundamental particles out there to be discovered at TeV scale.

- How does one search for new particles at the Tevatron?

  → We know what Standard Model events look like.

  → Look for events which are Un-Standard Model Like

Motivation [II]

- Analysis goal is to find incontrovertible evidence for new physics beyond the Standard Model using as a photon(s) signature.

- There are a large number of important and well-motivated theoretical models which make a strong case for looking for new physics in events with a photon in the final state.

- These theories include SUSY, Extra Dimensions (ED), Grand Unified Theories, Composite models, Anomalous couplings and Higgs models.

- SUSY ($N_2 \rightarrow \gamma N_1$, Light Gravitinos) ➡ **mSUGRA**
- Extra Dimensions ➡ **ADD & RS** **GMSB**
- Composite Models (Excited Leptons)
- Technicolour: Photon+Dijet
- Bosephilic Higgs: W/Z+Higgs $\rightarrow$ W/Z+$\gamma\gamma$
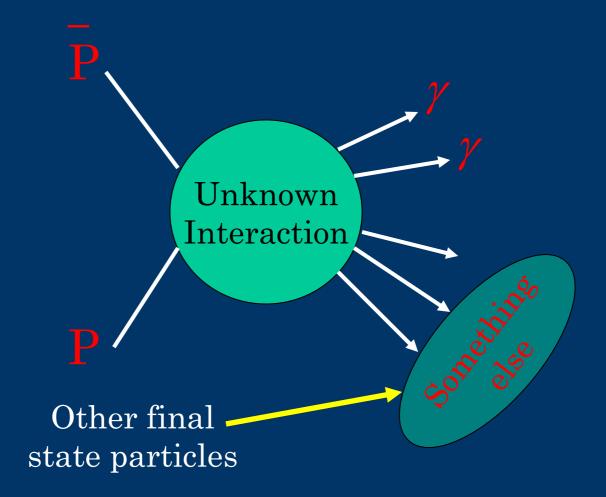- Anomalous W($\rightarrow \ell\nu$)/Z($\rightarrow \ell\ell$, $\nu\nu$) + γ production

Example Signature - SUSY

$\tilde{\chi}_1^0 \to \gamma \, \tilde{G}$

X

$W^{*\pm}$

$\tilde{\chi}_1^\pm$

q

$W^{*\pm}$

$\bar{q}$

$\tilde{\chi}_2^0$

Z^{*0}

X

$\tilde{\chi}_1^0 \to \gamma \, \tilde{G}$

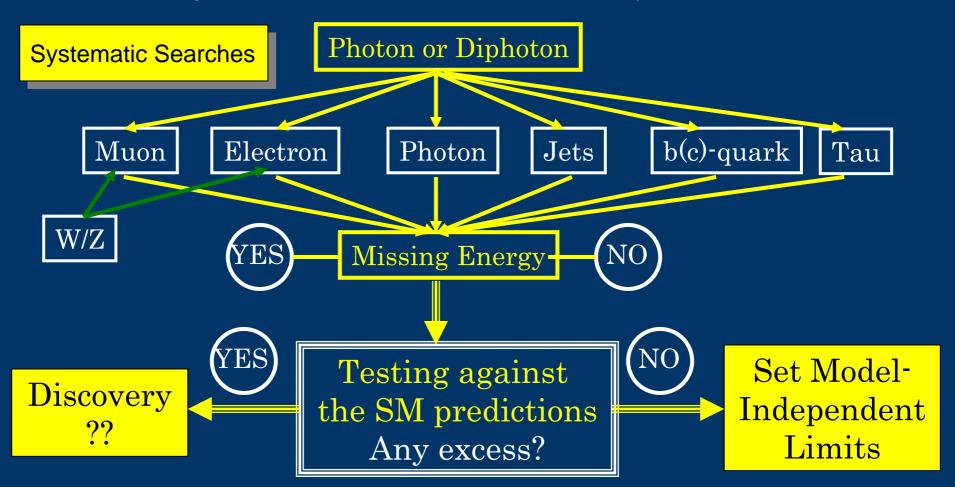$\gamma\gamma + \not{E}_T$: a sensitive signature for GMSB

Search Strategy [I]

- Model-independent searches for "New Physics" in the photon final state.

- The basic signatures: Photon(s)+X(additional object(s)) in the final-state.

$\bar{P}$

P

Unknown Interaction

γ

γ

Something else

Other final state particles

Search Strategy [II]

- Model-independent searches for "New Physics" in the photon final state.

- The basic signatures: Photon(s)+X(additional object(s)) in the final-state.

Event Selection

- New diphoton dataset [cdip0da_diphoton]
  - equivalent to 5.3.3_nt, dev_242_12 official prescriptions for calibrations, tagging, Zvertexing etc. [New Jet Correction]

- Global Event Selections
  - Two diphoton triggers in Central
  - $|Z_{vertex}| < 60$ cm
  - GoodRuns for diphoton analyses in 5.3.3 (435 pb^{-1})

- Standard Photon Identification and Isolation.

- Remove cosmic rays which brem or shower.

- Remove events caused by beam-related sources. [need to be updated; see highest MET event]

- Additional cuts to remove MET mis-measurement.

Photon Identification
Baseline Analysis Cuts for High Pt Photons V2.1

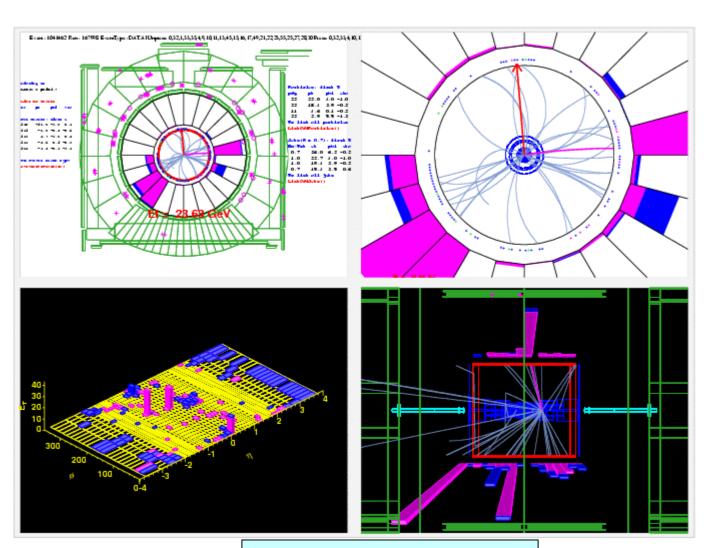| Variable	Cut
Had/EM	$< 0.125 \,||\, < 0.055 + 0.00045 * ECorr$
Chi2 (Strips+Wires)/2.0	< 20
N track (N3D)	$<=1$
Track Pt	$< 1+0.005*EtCorr$
Cone 0.4 IsoEtCorr	EtCorr<20: $< 0.1*EtCorr$ EtCorr>20: $< 2.0+0.02*(EtCorr-20.0)$
Cone 0.4 Track Iso	$< 2.0+0.005*EtCorr$
2nd CES cluster E*sin(theta) (strip and wire)	EtCorr<18: $< 0.14*EtCorr$ EtCorr>18: $< 2.4+0.01*EtCorr$
Fiducial	Ces $|X|<21$ cm, $9<$ Ces $|Z|<230$ cm
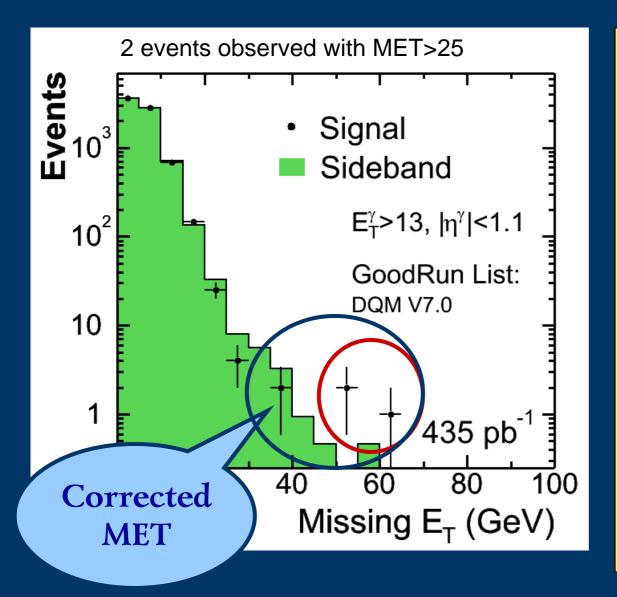
Two isolated central photons with Et > 13 GeV
7295 diphoton events pass all candidate selesction requirement.

[1] γγ+X Search, where X=MET

2 events observed with MET>25

- Signal
- Sideband

$E_T^\gamma > 13$, $|\eta^\gamma| < 1.1$

GoodRun List:
DQM V7.0

435 pb^{-1}

Corrected MET

- Natural extension of previous analysis [**CDF hep-ex/0410053**]

- $4.11.2 \rightarrow 5.3.3\_nt$

- 202 pb-1 $\rightarrow$ 435 pb^{-1}

- 5(3) events observed with MET>30(40) GeV

- trying to understand MET in 5.3.3_nt

- revisit to Gaussian MET model using 5.3.3 Z sample

- optimize MET cut

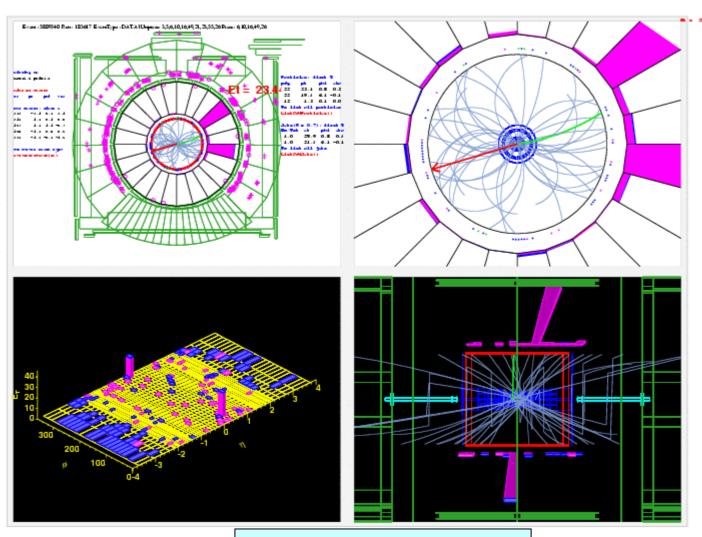- trying to reduce any non-collision backgrounds
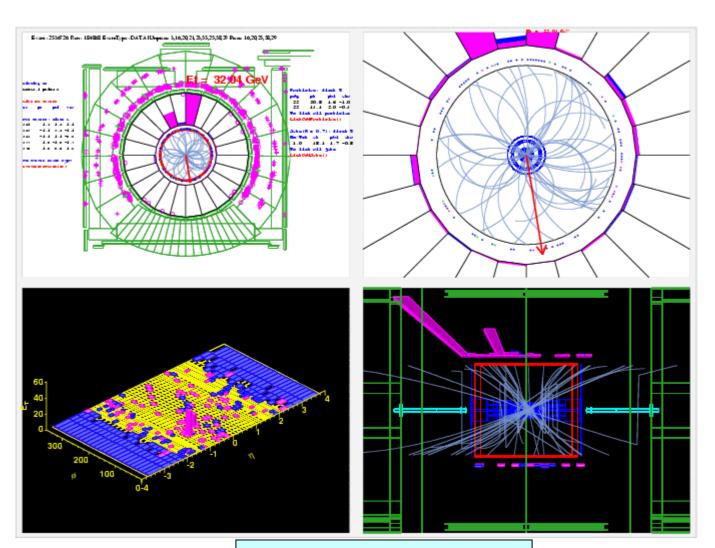
Et=(19,16), Met=39.9

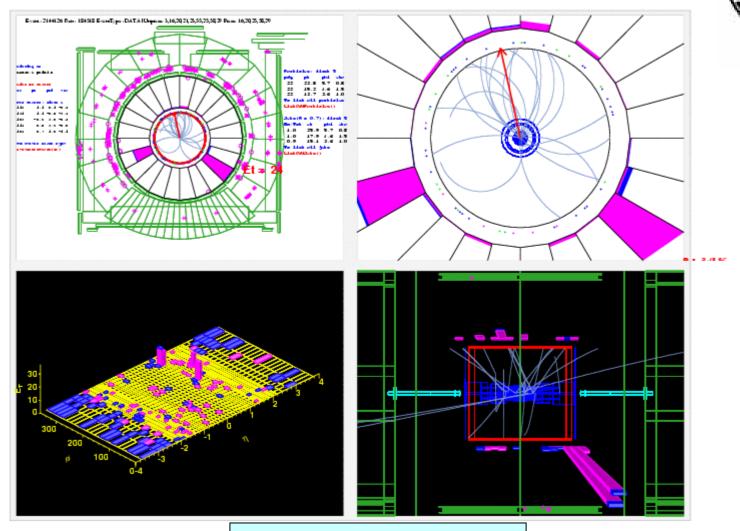**Et=(23,19), Met=36.2**

Et=(27,16), Met=50.8

Et=(31,14), Met=54.2

Et=(27,13), Met=64.5
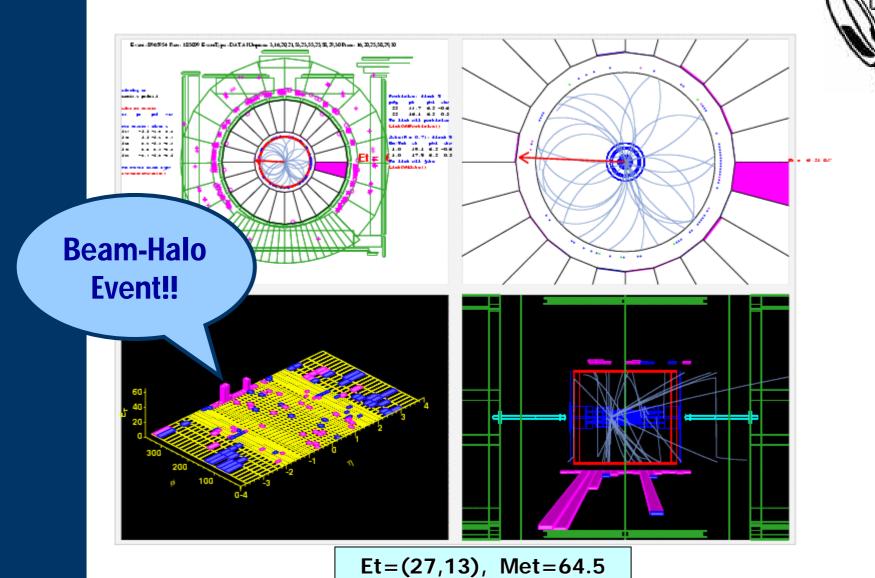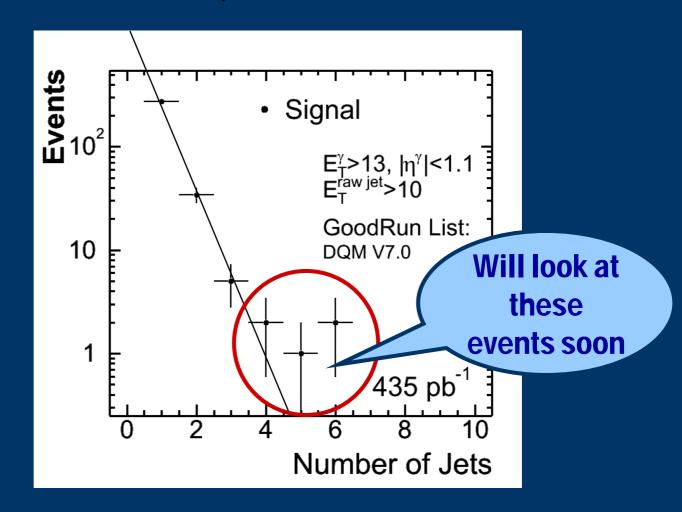
[2] γγ+X Search, where X=Jets

- In some models Higgs couples only to vector bosons

- These are know as "Bosophilic" or "fermiophobic" Higgs

- CDF can search for γγ production in association with a W/Z boson.

- Look in γγ data for anomalous production on associated jets from quark decays of W's

Next To Do...

- just start to look in ~400 pb^{-1} diphoton data for new physics search using model-independent manner.

- Object Identifications
  eg. Jets, b-tags, c-tags, electrons, muons, and taus

- fake rate studies.

- Understanding of the signal and background systematically.

HOPE TO OPEN THE (SOME) BOX SOON ☺

$E_T^\gamma > 12$ GeV Threshold		
Signature (Object)	Obs.	Expected
$\not{E}_T > 35$ GeV, $|\Delta\phi_{\not{E}_T-\text{jet}}| > 10°$	1	0.5 ± 0.1
$N_{\text{jet}} \geq 4$, $E_T^{\text{jet}} > 10$ GeV, $|\eta^{\text{jet}}| < 2.0$	2	1.6 ± 0.4
Central e or μ, $E_T^{e \text{ or } \mu} > 25$ GeV	3	0.3 ± 0.1
Central τ, $E_T^\tau > 25$ GeV	1	0.2 ± 0.1
b-tag, $E_T^b > 25$ GeV	2	1.3 ± 0.7
Central γ, $E_T^{\gamma 3} > 25$ GeV	0	0.1 ± 0.1
$E_T^\gamma > 25$ GeV Threshold		
Object	Obs.	Exp.
$\not{E}_T > 25$ GeV, $|\Delta\phi_{\not{E}_T-\text{jet}}| > 10°$	2	0.5 ± 0.1
$N_{\text{Jet}} \geq 3$, $E_T^{\text{Jet}} > 10$ GeV, $|\eta^{\text{Jet}}| < 2.0$	0	1.7 ± 1.5
Central e or μ, $E_T^{e \text{ or } \mu} > 25$ GeV	1	0.1 ± 0.1
Central τ, $E_T^\tau > 25$ GeV	0	0.03 ± 0.03
b-tag, $E_T^b > 25$ GeV	0	0.1 ± 0.1
Central γ, $E_T^{\gamma 3} > 25$ GeV	0	0.01 ± 0.0

Number of observed and expected $\gamma\gamma$ events with additional objects in 85 pb^{-1}